elms (*Tetraneura* and *Schizoneura*), and those of the poplar and pistachio (*Pemphigus* and *Aploneura*), or, at least, some of them, have a period during which the egg alone exists. From the 1st to the 6th January, however, the author found great numbers of *Vacuna dryoptrica*, male and female, in copulation under the leaves of an oak (*Quercus pubescens*).—*Comptes Rendus*, Jan. 12, 1880, p. 80.

Experimental Researches on the Phosphorescence of the Glowworm. By M. Jousset de Bellesme.

Electricity, the nervous fluid, insolation, and the vital forces have been invoked by turns as causes of phosphorescence. Finally we have rested upon the existence of a phosphorescent matter emitted by luminous animals, which appeared more probable. I have thought it necessary to examine afresh this phenomenon in the glowworm, because the investigations made by Matteucci, the principal experimenter who has paid attention to the matter, were by no means irreproachably conducted. In fact, neither this author nor others have, in their experiments, taken into account the will of the animal, or endeavoured to eliminate that cause of uncertainty; so that when they placed a glowworm in carbonic acid, for example, they could not exactly determine whether the phosphorescence ceased because the medium did not allow of its being produced, or because the animal voluntarily refused to shine. It was necessary, in the first place, to become master of the phenomenon, and for that purpose to prevent the animal from shining at its own pleasure, and force it to become luminous at that of the experimenter. With this view, I remove the cephalic ganglia, which abolishes all spontaneous phosphorescence; then I replace the voluntary excitation by the passage of a moderate electrical current in the trunk or in the luminous organ. This excitation causes, with certainty, a brilliant phosphorescence.

Possessed of this process, I proved, as Matteucci had done, that the presence of oxygen is in fact absolutely necessary in order that the luminous apparatus should perform its function. The insect, prepared as just described, and immersed in carbonic acid or inert gases, such as nitrogen and hydrogen, and electrically excited in those gases, never becomes luminous.

We may therefore regard it as certain that the large cells with granular protoplasm forming the parenchyma of the phosphorescent apparatus produce a substance which becomes luminous by contact with the air conveyed by the numerous tracheæ with which this apparatus is furrowed.

In order to know what this matter is, it was necessary to be able to isolate it and analyze it. This has already been attempted. The resemblance of the luminosity to that of phosphorus has led several chemists to seek for that substance in the luminous apparatus; but their researches have been in vain, so that naturalists have found themselves in presence of two contradictory assertions. The present memoir shows that this contradiction is only apparent, and that it arises from a bad interpretation of a well-known fact. When we crush a glowworm we most commonly see luminous traces persisting on the ground; from this it has been concluded that the case of its apparatus was the same as that of matches, and that these traces were nothing but a phosphorescent material accumulated in the apparatus for the ulterior needs of the insect. The experiment thus made is very defective; let us repeat it more methodically. If we confine ourselves to tearing up, with needles, a phosphorescent glowworm, the fragments remain luminous, at least for some hours. On the other hand, if we rapidly crush one of these insects in a mortar, so as to destroy the cells themselves, the phosphorescence immediately disappears; and the pulp, if collected, exposed to contact with pure oxygen, and subjected to the influence of electrical excitation, remains absolutely dark. Thus a partial crushing allows the phosphorescence still to be produced; complete crushing abolishes it. Upon the hypothesis of a store of phosphorescent matter, crushing carried very far would evidently be favourable to the production of light by spreading this matter over a large surface in contact with air; but the reverse of this takes place; the phosphorescence does not persist unless the apparatus is only reduced to fragments. This is due to the fact that groups of cells remaining intact continue to live and perform their functions. Tearing and the abnormal contact of the air excite them; and their protoplasm, reacting under these influences, produces the phosphorescent matter at the expense of the materials which it contains. If we kill these cells by crushing them, life no longer intervenes to set these materials at work and give them the chemical form under which phosphorescence can manifest itself.

We are therefore here in presence of a chemical phenomenon, but of one which is not produced in the glowworm, except under biological conditions. We can, moreover, prove this in another manner. Besides crushing, certain toxical agents have the power of destroying the cells. If we submit a glowworm to the action of sulphuretted hydrogen it is killed immediately. If we then take it and excite it electrically we obtain no light. The cells are intact as to their form, but physiologically destroyed; they no longer function. We may then tear the organ, and apply the action of oxygen and of electricity without provoking phosphorescence. It is certain, nevertheless, that this protoplasm contains all the materials chemically necessary for the production of the phosphorescent substance; but this substance is not ready made. It is only produced in proportion to the waste, under the influence of the will and by the intermediation of the nervous system, which excites the cells and causes them to enter into action. Phosphorescence is consequently a phenomenon of the same order as muscular movement, or the evolution of electricity in the apparatus of the torpedo, which are undoubtedly the result of chemical combinations taking place in the protoplasmic matter.

It is very probable that this phosphorescent substance is a gaseous product; for the structure of the gland, well investigated by Owsianikow, does not give us the idea of an organ with a liquid secretion. Now the chemical products which are phosphorescent at ordinary temperatures are not numerous; and the one of which one is led to think is phosphuretted hydrogen. It is for the chemists to elucidate this point; but, in consequence of the peculiarities just indicated, they must not attempt to ascertain its presence directly, but rather to see whether there are, in the cellular protoplasm of the apparatus, the materials necessary for the production of this gas.

What inclines me in favour of this hypothesis is the extreme resemblance that we observe between the phosphorescence of substances in decomposition, which is due to an evolution of phosphuretted hydrogen, and that of luminous animals. They present the same physical characters, the same affinity for oxygen, and only differ in this particular, that the cadaveric phosphorescence is continuous, like the decomposition of the substances which produce it, whilst the phosphorescence of the animals is intermittent. The latter is due to the fact that the cellular decomposition which sets free the luminous product, takes place in animals of high organization only under excitation of the nervous system, and in the lower animals (*Noctilucæ*) only by means of external excitants.

My investigations upon the glowworm and the experiments that I have made upon the *Noctilucæ* lead me to regard phosphorescence as a general property of protoplasm, consisting in an evolution of phosphuretted hydrogen. This mode of looking at it easily explains how many of the lower animals, although destitute of a nervous system, are phosphorescent. Further it presents the advantage of enabling us to connect the phenomena of phosphorescence observed in living creatures with those which are observed in organic matters in course of decomposition. It is another example of a biological phenomenon very clearly reduced to an exclusively chemical cause. —*Comptes Rendus*, February 16, 1880, p. 318.

On the French Jurassic Cidaridæ.
By M. G. Cotteau.

M. Cotteau, having completed the revision of the Jurassic Cidaridæ in the 'Paléontologie Française,' has communicated to the Geological Society of France an interesting summary of his results. Of French fossil urchins he refers to this family 121 species, of which 87 belong to the old genus *Cidaris*, 25 to *Rhabdocidaris*, and 9 to *Diplocidaris*. The 121 species all belong to the Jurassic epoch: none of them existed before it; and none occur in the Cretaceous deposits. Most of them are also limited to a single stage of the Jurassic.

The Rhætic stage contains a single peculiar species. The Sinemurian (Infra-Lias) has 7 peculiar species, mostly represented by detached spines. The Liassic stage possesses 10 species, 9 of which are confined to it, while the tenth extends up into the next stage, the Toarcian (Upper Lias shale), which, however, contains only 3 species in all. The species just referred to (*Rhabdocidaris horrida*) also passes into the Bajocian (Inferior Oolite) stage, in which the